MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 3 , 2016/2017

ERT3026 – AUTOMATION
(RE)

31 MAY 2017
9.00 a.m. – 11.00 a.m.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 7 **pages** including cover page and Appendix with **4 Questions** only.

2. Attempt **ALL** questions. The distribution of the marks for each question is given.

3. Please write all your answers in the Answer Booklet provided.

Question 1

(a) A strain gauge has a resistance of 200Ω and gauge factor of 2.2. R_2, R_3, R_4 are fixed resistor also rated at 220 Ω. The strain gauge experiences a tensile strain of 450μ due to the displacement of an object. Determine the change in resistance of the strain gauge. If the input voltage is 4V then determine the change in output as shown in Figure Q1 (a). **[7 marks]**

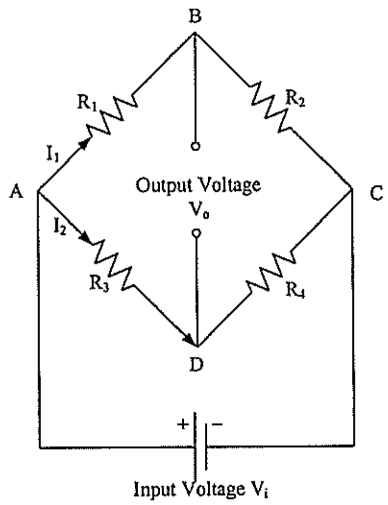

Figure Q1 (a)

(b) An IC manufacturing factory require a sensor to measure the temperature in a 55° C band and accurately measure very small temperature change. Choose the correct sensor and give the reason. **[5 marks]**

(c) A painting robot is using a double-acting hydraulic cylinder to actuate a linear joint. The hydraulic power source can generate up to 6.0MPa of pressure at a flow rate of 0.0003m^3/sec to drive the piston. The maximum velocity of the piston that can be applied in the forward stroke is 0.045 m/sec and the maximum velocity of the piston that can be applied in the reverse stroke is 0.047 m/sec.

(i) Determine the inside diameter of the cylinder and the piston rod diameter. **[9 marks]**

(ii) Determine the forces that can be applied in the forward stroke and reverse stroke. **[4 marks]**

Continued...

Question 2

(a) Write a programmable logic controller (PLC) ladder diagram to control the lubricating oil being dispensed from a tank as shown in the **Figure Q2.(a)** by using the Input/Output assignment as shown in **Table Q2-(a),**

This is possible by using two sensors, high level sensor put near the top and low level sensor put near the bottom.

The fill-motor will pump lubricating oil into the tank until the high level sensor turns on. At that point, turn off the motor until the level falls below the low level sensor. Then turn on the fill motor and repeat the process.

[8 marks]

Table Q2-(a) The Input/Output Assignment for Question 2(a)

Input Address	Input Device	Output Address	Output Device
0.02	Low Level Sensor	2.01	Fill Motor
0.03	High Level Sensor		

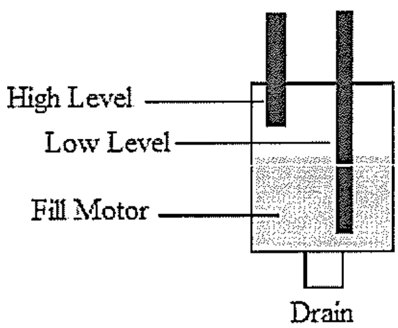

Figure Q2.(a): Dispensing Oil from a Tank

Continued...

Question 2

(b) Write a programmable logic controller (PLC) ladder diagram to control forward and reverse running of the motor as shown in the **Figure Q2(b)** by using the Input/Output assignment as shown in **Table Q2(b)**

This is possible by using two switches forward switch (X0) and reverse switch (X1) and the operation condition as follows:

- The forward switch is pressed,
- After 1 second, contactor Y0 will be enable and the motor run forward.
- The reverse switch is pressed,
- After 2 second, contactor Y1 will be enable and the motor run reverse.
- Y0 and Y1 will be disabling and the motor will stop running.

[17 marks]

Table Q2-(b) The Input/Output Assignment for Question 2(b)

Input Address	**Input Devices**
0.00	Push Button Switch (X0)
0.01	Push Button Switch (X1)
0.02	Push Button Switch (X2)
T0000	Timer One (1 sec)
T0001	Timer Two (2 sec)
Output Address	**Output Devices**
2.00	Forward Running(Y0)
2.01	Reverse Running(Y1)

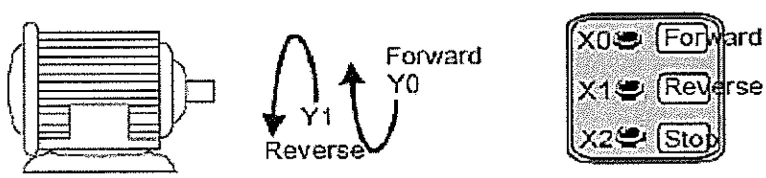

Figure Q2.(b): Motor for Question 2(b)

Continued...

Question 3

(a) An eight-station rotary indexing machine performs the machining operations as shown in the **Table Q3.** The transfer time for the machine is 0.15 min per cycle. A study of the system was undertaken, during which time 2000 parts were completed. It was determined in this study that when breakdown occur, it takes an average of 7.0 min to make repairs and get the system operating again. For the study period, determine:-

(i) average actual production rate, **[12 marks]**

(ii) line uptime efficiency **[3 marks]**

Table Q3

Station	Process	Process time	Breakdowns
1	Load part	0.50 min	1
2	Mill top	0.85 min	50
3	Mill sides	1.10 min	75
4	Drill two holes	0.60 min	10
5	Ream two holes	0.43 min	23
6	Drill six holes	0.92 min	60
7	Tap six holes	0.75 min	30
8	Unload part	0.40 min	1

(b) An overhead continuous conveyor is used to carry dishwasher base parts along a manual assembly line while components are being added to them. The spacing between appliances = 3.0 m and the speed of the conveyor = 2.0 m/min. The length of each workstation is 4.0 m. There are a total of 20 stations, five of which have two workers. There are also 5 utility workers assigned to the line.
Determine:

(i) cycle time and feed rate, **[6 marks]**

(ii) tolerance time, and **[2 marks]**

(iii) elapsed time a dishwasher base part spends on the line. **[2 marks]**

Continued...

Question 4

A semi-automated flexible manufacturing cell (FMC) is used to produce three products. The products are made by two automated processing stations followed by an assembly station. There is also a load/unload station. Material handling between stations in the FMC is accomplished by mechanized carts that move tote bins containing the particular components to be processed and then assembled into a given product. The carts transfer tote bins between stations. In this way the carts are kept busy while the tote bins are queued in front of the workstations. Each tote bin remains with the product throughout processing and assembly. The details of the FMC can be summarized as shown Table Q4.1:

Table Q4.1

Station	Description	Number of servers
1	Load and unload	2 human workers
2	Process X	1 automated server
3	Process Y	1 automated server
4	Assembly	2 human workers
5	Transport	Number of carriers to be determined.

The product mix fractions and station processing times for the parts are presented in the Table Q4.2. The same station sequence is followed by all products: **1→2 →3 →4 →1.**

Table Q4.2

Product j	Product mix p_j	Station 1	Station 2	Station 3	Station 4	Station 1
A	0.35	3 min	9 min	7 min	5 min	2 min
B	0.25	3 min	5 min	8 min	5 min	2 min
C	0.40	3 min	4 min	6 min	8 min	2 min

The average cart transfer time between stations is 4 minutes.

(a) What is the bottleneck station in the FMC, assuming that the material handling system is not the bottleneck? **[10 marks]**

(b) At full capacity, what are the overall production rate of the system and the rate for each product? **[6 marks]**

(c) What is the minimum number of carts in the material handling system required to keep up with the production workstations? **[2 marks]**

(d) Compute the overall utilization of the FMC. **[7 marks]**

End of Page

APPENDIX

$T_p = T_c + FT_d$	$R_p = \dfrac{1}{T_p}$	$T_p = T_c + \sum_j F_j T_{dj}$
$WL = R_f T_C$	$T_C = T_L + \dfrac{L_d}{v_C} + T_U + \dfrac{L_e}{v_e}$ $T_d = \dfrac{L_d}{v_C}$	$AT = 60 AT_f E$ $R_f = R_L = \dfrac{v_c}{S_c} \leq \dfrac{1}{T_L}$
$n_C = \dfrac{WL}{AT}$ $R_{dv} = \dfrac{AT}{T_C}$ $F = \sum_i^n p_i$	$f_p = 1/T_c$ $T_c = s_p / v_c$ $T_C = Max\{T_{si}\} + T_r$	$D = \dfrac{FT_d}{T_p}$ $E = \dfrac{T_c}{T_p}$
$d = \dfrac{nT_s - T_{wc}}{nT_s}$	$WL_i = \sum_j \sum_k t_{ijk} f_{ijk} p_j$	$n_t = \left(\sum_i \sum_j \sum_k f_{ijk} p_j \right) - 1$
$WL_{n+1} = n_t t_{n+1}$	$R_p^* = \dfrac{s^*}{WL^*}$	$R_{pj}^* = p_j (R_p^*) = p_j \dfrac{s^*}{WL^*}$
$U_i = \dfrac{WL_i}{s_i} (R_p^*)$	$\overline{U} = \dfrac{\sum_{i+1}^{n+1} U_i}{n+1}$	$\overline{U_s} = \dfrac{\sum_{i+1}^{n+1} s_i U_i}{\sum_{i=1}^{n} s_i}$
$\sigma = \dfrac{F}{A}$ $\varepsilon = \dfrac{\sigma}{E}$	$F_i = PA_i$ $V = \dfrac{Q}{A}$	$G = \dfrac{\Delta R / R}{\varepsilon}$ $\Delta V_0 = V_1 \left(\dfrac{\Delta R_1}{R_1 + R_2} \right)$